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Southern Pines Performance on Sandhills Sites in Georgia and South Carolina

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ABSTRACT. *Choctawhatchee sand pine (*Pinus clausa *var.* immuginata *D.B. Ward), Ocala sand pine (*P. clausa *var.* clausa *D.B. Ward), slash pine* (P. elliottii *Engelm.), loblolly pine* (P. taeda *L.), and longleaf pine* (P. palustris *Mill.) were grown on sandhills in Georgia and South Carolina. Choctawhatchee sand pine grew fastest and yielded the most volume after 28 yr. Productivity equaled that of plantations in northwest Florida, averaging more than 100 ft^3/ac/yr. To maximize yields for pulpwood rotations of 25 to 35 yr, managers should plant these sites to Choctawhatchee sand pine. Longleaf pine, however, has been growing as fast as Choctawhatchee sand pine since age 15 yr. Therefore, especially for longer rotations, it would be an acceptable alternative species. South. J. Appl. For. 17(2): 00–00.*

Sandhills, marine deposits from the Pleistocene epoch, occupy significant acreage in the Southeastern United States. They are an important physiographic feature of central and northwest Florida, and in the transition zone between the Upper Coastal Plain and the Piedmont in Georgia, South Carolina, and North Carolina. Sandhills soils are typically acid, infertile, and droughty. Many are quartz sands, ranging from a few feet to more than 20-ft deep. Because the soils are low in organic matter and clay content, nutrient and water retention are quite poor.

Relatively open stands of longleaf pine once dominated most sandhills, but only scattered patches remain. Many sites were taken over by scrub oaks, principally turkey (*Quercus laevis* Walt.), bluejack (*Q. incana* Bartr.), and sand post oak (*Q. stellata* var. *margaretta* [Ashe] Sarg.), following harvest of the longleaf pine in the early 1900s.

Research has shown that Choctawhatchee sand pine performs best on the sandhills of northwest Florida (Brendemuehl 1981). This study was established to compare southern pine species on sandhills sites in Georgia and South Carolina. Choctawhatchee sand pine was the best species in this test after 15 yr (Hebb 1982). A survey of plantations in Georgia showed Choctawhatchee sand pine growth rate was comparable to that observed in Florida, and yields were better than those expected for other southern pines on sandhills sites (Outcalt and Brendemuehl 1985). No information exists, however, comparing Choctawhatchee sand pine with other southern pines on sandhills in Georgia or South Carolina beyond 15 yr. Reported here are such data, including expected yields for a pulpwood rotation of 28 yr.

Methods

The Georgia test site is in the west central area near Geneva on land formerly owned by Georgia Kraft. The South Carolina site is on the Sand Hills State Forest in the north central portion of the state, near Cheraw. Soil on the South Carolina site is Troup loamy sand (thermic Grossarenic Paleudult), and the Georgia site has an Alaga coarse loamy sand (thermic Typic Quartzipsamment).

The South Carolina site was root-raked and disked in 1962 and planted to watermelons in 1963. This site received both cultivation and fertilization during watermelon production. The Georgia site was cleared with a bulldozer with the blade set just above the soil surface in December 1963. At each location, 25 plots, 84 × 84 ft, were established with a 10-ft buffer strip between all plots. Five plots each were selected for Choctawhatchee sand pine, Ocala sand pine, slash pine, loblolly pine, and longleaf pine in a Latin square design. All plots were hand-planted in February 1964 at a 6 × 6-ft spacing. A two-row buffer strip of slash pine was planted around each set of plots. Sand pine seedlings were from the Chipola Experimental Forest nursery in northwest Florida, while other species came from state nurseries in Georgia and South Carolina.

Hardwood sprouts on half of each plot were sprayed twice with 2,4,5-T the year following planting. Previous analyses showed this had no affect on early survival or growth. In an attempt to increase stocking, the unoccupied spots in longleaf plots were direct-seeded with five repellent treated seeds in January 1965. This was largely unsuccessful, increasing stock-

ing from 12–17% in Georgia and from 57–60% in South Carolina. In July, 1970, to equalize stocking, all plots were thinned to 400 trees/ac at the Georgia location and to 565 trees/ac for the South Carolina site. Bark beetle (*Ips* spp.) attacks following thinning further reduced the stocking at the Georgia location.

At age 28 yr, in September 1991, trees on all plots except those planted to Ocala sand pine were remeasured. Ocala sand pine plots were not measured because inspection showed 100% mortality on all plots. The height and diameter were determined for all trees on a 66 ft^2 interior measurement plot. These data were used to calculate individual tree basal area and volume. Significant differences between species were determined using analyses of variance.

Results

Mortality during the last 13 yr has been comparatively high for slash pine at Georgia and South Carolina locations (Table 1). Mortality differed by location for the other three species, but none had unacceptable mortality since age 15. After 28 yr, stocking was adequate for all but longleaf pine at the Georgia site. Choctawhatchee sand pine had the largest average diameter while longleaf pine ranked second. Loblolly and slash pine had significantly smaller mean diameters at both locations.

Choctawhatchee sand pine was significantly taller on average than other pines after 28 yr. As with diameter, longleaf ranked second while slash and loblolly were both significantly shorter. Basal area was less than 100 ft^2/ac for all but Choctawhatchee sand pine in Georgia and Choctawhatchee and longleaf pine in South Carolina. In Georgia, Choctawhatchee sand pine produced nearly three times as much wood volume as the other species. Slash and loblolly pine volumes were also lowest on the South Carolina site. Although longleaf pine had much greater survival and yields in South Carolina than in Georgia, Choctawhatchee sand pine still had significantly more volume, but not more biomass.

Average height growth rate over the last 23 yr on the South Carolina location has been the same for Choctawhatchee sand pine and longleaf pine, 1.7 ft/yr (Figure 1). Choctawhatchee

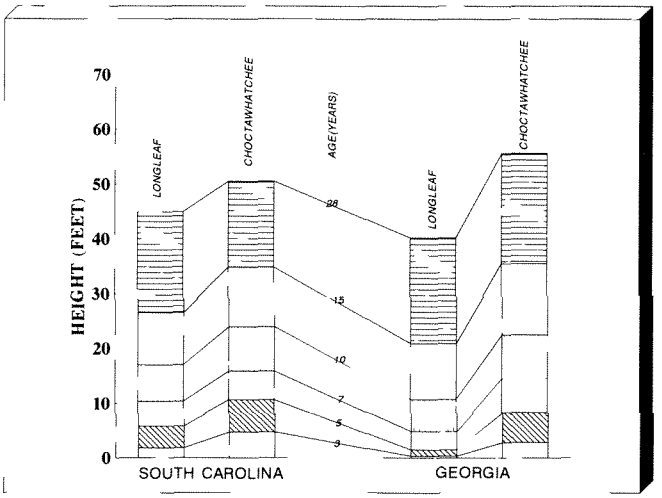

Figure 1. Twenty-eight-year height growth of longleaf and Choctawhatchee sand pine on sandhills in South Carolina and Georgia.

sand pine grew somewhat faster from age 5 to 15 yr, but since then longleaf has been growing slightly faster. Longleaf pine at the Georgia site had the same average rate of height growth as in South Carolina at 1.7 ft/yr, but Choctawhatchee sand pine has been slightly greater at 2.1 ft. For the last 13 yr, however, both species have averaged 1.5 ft of height growth per year. Volume production has followed a similar trend at the South Carolina site since age 15, with longleaf pine producing 102 ft^3/yr and Choctawhatchee sand pine 114 ft^3/yr.

Discussion

Ocala sand pine is unsuited for planting in Georgia and South Carolina because of high mortality rates from sand pine root disease. Any existing stands should be harvested before 20 yr old to reduce losses. Slash pine at both locations was quite heavily infected with fusiform rust (*Cronartium fusiforme* Hedgc. et Hunt) which caused the high mortality over the last 13 yr. Choctawhatchee sand pine had relatively high mortality on the

Table 1. Tree and stand characteristics of 28-yr-old southern pines planted on sandhills sites in Georgia and South Carolina

	Mortality[1] %	Stocking trees/ac	Average diameter in.	Average height ft	Total basal area ft^2/ac	Total[2] volume ft^3/ac	Total[3] biomass ton/ac
Species				Georgia			
Slash Pine	31c[4]	336	5.4a	34.6b	69a	1080a	16.0a
Loblolly pine	5a	346	5.7a	29.4a	61a	714a	11.4a
Longleaf pine	10b	182	6.8b	40.2c	44a	760a	13.4a
Choctawhatchee sand pine	2a	264	9.1c	55.6d	115b	2770b	38.4b
				South Carolina			
Slash pine	22c	424	5.5a	37.8a	70a	1030a	16.3a
Loblolly pine	11b	490	6.0b	37.1a	95b	1410a	22.6a
Longleaf pine	4a	532	6.3c	44.9b	117bc	2280b	40.1b
Choctawhatchee sand pine	9b	478	7.2d	50.5c	135c	3000c	41.6b

[1] Mortality between 15 and 28 years of age.
[2] Stem volume inside bark based on equation by Bailey et al. (1982) for slash pine, Bailey and Clutter (1970) for loblolly pine, Farrar (1981) for longleaf pine, and McNab et al. (1985) for Choctawhatchee sand pine.
[3] Dry weight of stem wood based on equation by Bailey et al. (1982) for slash pine, Taras and Clark (1975) for loblolly pine, Taras and Clark (1977) for longleaf pine, and McNab et al. (1985) for Choctawhatchee sand pine.
[4] Within a column by location values followed by the same letter are not significantly different at the .05 level.

Georgia site from an infestation of bark beetles following the thinning operation at age 7 yr. Bark beetle attacks and tree mortality can be minimized by avoiding damage to residual trees. Mortality rate has been low for Choctawhatchee sand pine at both locations since age 15. This agrees with results for unthinned plantations in northwest Florida where mortality rates are normally less than 1% a year beyond age 3 yr. Most of the Choctawhatchee sand pine trees that did die between 15 and 28 yr were windthrown. This likely resulted from attack by root rot fungi.

Stocking differed between species and locations, but all were adequate except longleaf pine plots in Georgia. The low basal area there was due to poor initial survival caused by poor planting stock. Most of the longleaf seedlings for that site were wilted before planting. With proper seedling production and care during transport and planting, good survival can now be obtained when planting longleaf pine (Barnett et al. 1990).

Choctawhatchee sand pine averaged more than 50 ft in height at both locations after 28 yr. This is comparable to height growth for Florida, where plantation-grown trees averaged 54 ft at age 28 (Burns 1969). Volume production at 2770 and 3000 ft^3/ac also falls in the 2600 to 3000 ft^3/ac range reported for northwest Florida. Thus, on sandhills sites in Georgia and South Carolina, Choctawhatchee sand pine can produce more volume on a pulpwood rotation than any other southern pine with yields equal to those for plantations in its natural range in northwest Florida. Therefore, Choctawhatchee sand pine is the preferred species for pulpwood production on Georgia and South Carolina sandhills.

In South Carolina, the average height growth rate for longleaf pine has matched that for Choctawhatchee sand pine since age 5 yr. On the Georgia site, growth has been slightly less, but part of this may be due to 30% of the longleaf seedlings being 2 yr younger because they were established by spot seeding. Choctawhatchee sand pine has faster height growth the first 5 yr, while longleaf is in the grass stage, but rates began to equalize beyond this age. A valid comparison of longleaf and Choctawhatchee sand pine productivity cannot be made for the Georgia site because of the low stocking of longleaf. Although sand pine had produced more volume between ages 15 and 28 yr on the South Carolina site, longleaf volume production has been nearly as great. Because of higher specific gravity, longleaf pine has produced as much biomass as Choctawhatchee sand pine. Therefore, longleaf pine is also a viable species on these sites, especially with longer rotations.

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